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MORPHOLOGY AND TAXONOMY OF THE AURORA CHARR, *Salvelinus fontinalis timagamiensis*

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by
S. U. Qadri

NOTE

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MORPHOLOGY AND TAXONOMY OF THE AURORA CHARR, *Salvelinus fontinalis timagamiensis*[*]

By S. U. Qadri[†]

RÉSUMÉ

Henn et Rinkenbach ont décrit en 1925 une nouvelle espèce, *Salvelinus timagamiensis*, l'omble aurore, qui habite l'Ontario (Canada). Ils ont cru qu'elle se rattachait au groupe *Salvelinus alpinus*, mais d'autres auteurs se sont avisés par la suite qu'elle ressemblait davantage à l'omble de fontaine, *Salvelinus fontinalis*. Mon étude révèle que le maxillaire, le supramaxillaire et le dentaire de l'omble aurore sont un peu plus développés que ceux de l'omble de fontaine. La nageoire dorsale est située plus en arrière, et les nageoires anale et adipeuse se trouvent quelque peu plus en avant chez l'omble aurore que chez l'omble de fontaine. Les coefficients de différence entre l'omble aurore et l'omble de fontaine sont d'un peu plus de 1.28 quant au nombre de vertèbres du tronc, quant aux vertèbres précaudales et aux épines à nerf unique, ce qui situe la parenté des deux poissons au niveau des sous-espèces.

L'omble aurore et l'omble de fontaine s'hybrident fréquemment dans la nature, et ils sont plus précoces que les espèces voisines dans leur écologie, leur comportement à l'époque du frai, et leur taux de croissance. Les renseignements dont on dispose désignent donc l'omble aurore comme une sous-espèce, *Salvelinus fontinalis timagamiensis* Henn et Rinkenbach.

SUMMARY

Henn and Rinkenbach (1925) described a new species, *Salvelinus timagamiensis*, the aurora charr, from Ontario, Canada, believing it belonged to the *Salvelinus alpinus* complex. But later, authors thought the aurora charr more closely resembled the brook charr, *Salvelinus fontinalis*. My study shows that the maxilla, supramaxilla, and dentary are slightly larger in the aurora charr than in the brook charr. The dorsal fin is located slightly more posteriorly, and the anal and adipose fins are located somewhat more anteriorly in the aurora charr than in the brook charr. The coefficients of difference between the aurora charr and the brook charr are slightly higher than 1.28 for the number of trunk vertebrae, the precaudal vertebrae, and the single neural spines; these differences suggest a subspecific differentiation.

The aurora and brook charrs hybridize frequently in natural surroundings and are similar in ecology, spawning behaviour, and rates of growth. Available information indicates that the aurora charr should be recognized subspecifically as *Salvelinus fontinalis timagamiensis* Henn and Rinkenbach.

INTRODUCTION

The systematics of charrs (genus *Salvelinus*) is controversial. Since these fishes are very plastic, individual, local, and seasonal differences are often observed in their morphology and colour. These differences are the basis for the creation of unnecessary taxa by the early taxonomists. With the advent of new systematics, revisions and reappraisals of the salmonoid fishes have reduced the number of genera and species in that group (McPhail 1961; Norden 1961; Qadri 1964). The present study clarifies the status of the aurora charr.

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[*] Based on a portion of a doctoral thesis submitted to the University of Ottawa, Ottawa, Ontario, in 1964.

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The aurora charr, *Salvelinus timagamiensis*, from the Timagami Forest Reserve in Ontario, was first described as a distinct species by Henn and Rinkenbach in 1925. They thought the fish belonged to the *Salvelinus alpinus* complex: at present this view is not accepted (Martin 1939; Dymond 1947; Qadri 1964). Kendall, in a letter to MacKay in 1929 (MacKay 1963), assigned species status to the aurora charr, basing his conclusion on written accounts. He did not examine any specimens. Martin (1939) thought that the aurora charr was very similar to the brook charr, *Salvelinus fontinalis* (Mitchill). Dymond (1947) and Vladykov (1954) considered it a subspecies and a colour variety of the brook charr, respectively. Scott (1958), though hesitating to give it specific or subspecific status pending further study, listed it as a species. MacKay (1963) described it as a species. Sale (1964) thought it a subspecies of the brook charr. However, a detailed morphological study of the fish was overdue. My study incorporates the results of earlier studies on the biology and morphology of the fish and introduces new data to support the subspecific designation of the aurora charr.

At present the aurora charr is only found in Wilderness and Whirligig lakes, Ontario. To save this fish from extinction, proper protection should be provided by the Department of Lands and Forests of the province.

MATERIALS AND METHODS

The number, sizes, and sources of the fish used for morphological study are shown in Table I. Most of the fish were also used for meristic counts, and their exact numbers are mentioned at appropriate places in this paper. Brook charr were collected from natural populations. Aurora charr were taken from hatchery stock, with the exception of the Whirligig Lake sample, which came from a natural population. Since no morphological differences were observed between the hatchery stock and the natural population of the aurora charr, the samples were combined to calculate the mean values. The alcoholic specimens are stored in the ichthyological collection of the National Museum of Canada.

All morphometric measurements and meristic counts were made on the left side of the fish. Morphometric measurements were made with the aid of vernier calipers, dividers, and a ruler graduated in millimetres, and with or without the help of a dissecting binocular microscope. The paired cranial bones, e.g., the maxillae, are usually discussed in singular form.

Measurements of the Skeletal Parts. Although measurements were made of 17 cranial bones, only the total length (L) and maximum width (W) of the maxilla, supramaxilla, and dentary are used in this study. In the case of the maxilla, L_1 represents the length of the head, the anterior part of the maxilla without teeth; W represents maximum width of the posterior flat region, the part of the bone without teeth. For the dentary, the maximum width was measured between the posterior ends of the upper and lower arms.

Measurements of the Body Parts. Morphometric measurements were adapted from Vladykov (1954) and Hubbs and Lagler (1958). Fifty measurements were made on each fish; however, only the nine most important were selected for this study:

FL	Fork length
aD	Predorsal fin length
V–A	Distance from the origin of the ventral fin to the origin of the anal fin
D–ad	Distance from the insertion of the dorsal fin to the origin of the adipose fin
ma–V	Distance from the anterior tip of the lower jaw to the origin of the ventral fin
I	Interorbital space
ML	Length of the snout from the anterior end of the premaxilla to the front margin of the cartilaginous eyeball
Mx	Length of the upper jaw (the premaxilla and the maxilla combined)
ma	Length of the lower jaw (the dentary and the angular combined)

Meristic Characters. Some counts of meristic characters were made from alizarin-stained specimens and some from X-ray plates. Total counts were made

TABLE I

NUMBER, SIZE, AND LOCALITY OF THE FISH STUDIED

Sub[illegible]	[illegible] es	Locality: Abbreviation, (*see* Fig. 1)	Locality: Area	Locality: Lake	No. of fish	Fork length mm
Salvelinus fontinalis fontinalis	(Brook charr), speckled charr, brook trout, eastern brook trout, salmon trout, red-bellied trout, red-spotted trout, square-tail trout	1	Ontario	Lavieille	13	178–432 (292.0)
		2	Quebec	Laurentide Park	6	201–270 (241.7)
		3	Quebec	St. Germain	1	181
		4	Quebec	Clearwater River at mouth of East Richmond Gulf	10	135–182 (158.4)
		5	Labrador	Slimy Lake, near Knob Lake	7	111–175 (134.9)
		6	Maine USA	Pushineer	7	150–276 (223.7)
					Total 44	111–432 (216.3)
Salvelinus fontinalis timagamiensis	(Aurora charr), aurora trout, salmon trout, land-locked salmon	7	Ontario	Whirligig	15	275–428 (335.1)
		8	Ontario	Seahorse	6	350–397 (365.6)
		9	Ontario	Hill's Lake Hatchery, Charlton	5	146–193 (173.2)
		10	Ontario	Reed	3	348–386 (365.7)
					Total 29	146–428 (316.6)

on many structures, but only the following were used in this report: the vertebrae; the neural spines, normal and expanded; the ribs; the epineurals; the gill rakers on the first left gill arch; the branchiostegals; the fin rays, principal and rudimentary, in the dorsal, anal, pectoral, and pelvic fins. Also counted were the trunk vertebrae and the ribs with strongly bifid heads.

Statistical Procedure. To determine the degree of the overlap in several meristic characters of the fish, the coefficient of difference (CD) values

$$\left(\mathrm{CD} = \frac{\text{Mean for population } b - \text{Mean for population } a}{\text{Standard deviation for population } a + \text{Standard deviation for population } b} = \frac{\bar{X}_b - \bar{X}_a}{S_a + S_b}\right)$$

were calculated as prescribed by Mayr *et al.* (1953). These authors consider values of 1.28 and higher as indicative of subspecific level of differentiation. At this value, 90 per cent of the animals of one population differ from 90 per cent of the animals of the other population of the species.

DISTRIBUTION

Until the early 1950's the aurora charr naturally occurred in Whirligig, Whitepine, and Wilderness lakes in the Timagami Forest Reserve (MacKay 1963). Now it is found only in Whirligig and Wilderness lakes (Sale 1967). These lakes are situated at about 47°25′ N lat. and 80°39′ W long. at an altitude of about 1,300 feet above sea-level in a hilly, forested area of the Precambrian Shield. The forest consists of pine, spruce, balsam, cedar, poplar, and tamarack. These and a few other lakes drain into the east branch of the Montreal River, which drains into the St. Lawrence River system. Approximate locations of the Whitepine, Whirligig, and Wilderness lakes are shown in Figure 1, and their

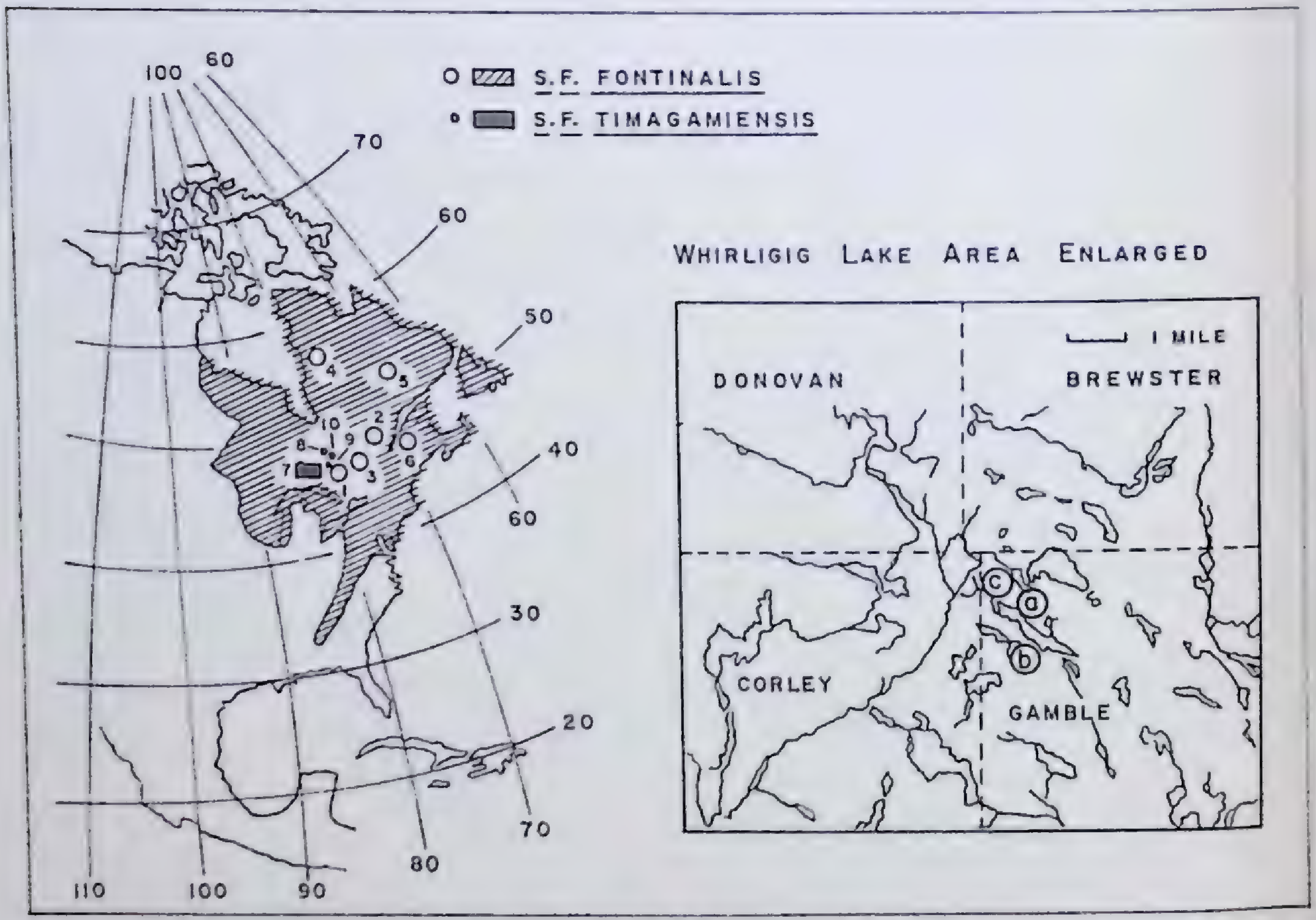

FIGURE 1—Distribution of *S.f. fontinalis* and *S.f. timagamiensis*. Specimens from numbered locations are those used for this study. Whirligig Lake Area, number 7, enlarged: a) Whitepine Lake, b) Whirligig Lake, c) Wilderness Lake.

brief descriptions are presented below. For a detailed description of the three lakes, including the chemical properties of the water, consult Sale (1967). Figure 1 also shows the natural distribution of the brook charr (*S. f. fontinalis*).

Whitepine is nearly three miles long with a maximum width of one-quarter mile and occupies an area of 192 acres. Its average depth is 30 feet. Whirligig is southwest of Whitepine and is about 28 acres in area. Its maximum depth is 38 feet. Wilderness is 10 acres in area and has a maximum depth of 35 feet.

Recently the aurora charr was planted in Seahorse and Reed lakes (MacKay 1963).

OSTEOLOGY, MORPHOLOGY, COLOUR, AND BIOLOGY

The typological concept of the species is declining in importance (Simpson 1951). Emphasis now is placed on the nondimensional and the multidimensional species concepts, and the biological species definition is now accepted (Stresemann 1919; Rensch 1929; and DuRietz 1930). Definitions of the species by Dobzhansky ([illegible]), Simpson (1961), and Mayr (1963) differ somewhat. The following definition by Mayr is accepted in this paper, "A species is a group of actually or potentially interbreeding natural populations which are reproductively isolated from other such groups." *Salvelinus fontinalis*, including its various forms, conforms to this definition and therefore was acceptable as a distinct species (Hubbs and Lagler 1958; Norden 1961). Many characteristics of the brook charr, derived from my study and from the literature, are enumerated below.

In the genus *Salvelinus* only the brook and aurora charrs frequently have the hypethmoid bone.

The following characteristics define the brook charr:

Supraethmoid bone	Rounded front head and is broad caudad.
Maxilla	Projects well behind the orbit of the eye.
Supramaxilla	Not broad posteriorly.
Postorbital-I	Uniquely shaped compared to other charrs, since it is notched at about the middle of the posterior margin.
Uroneural-I	Distinctly broad and short.
Vertebrae	58–61
Neural arches not fused with the vertebrae	26–30
Single neural spines	20–29
Ribs	31–36
Epineurals	29–35
Gill rakers	15–22
Branchiostegals	10–12
Basibranchial teeth	0–9
Pores on the lateral line scales	112–123
Tail	Square in the adult fish.
Salmincola edwardsii	In North America this parasite is found only on the brook charr.

The brook charr is distributed in eastern North America including Newfoundland (Figure 1). In the subsections below, some of the characteristics of the brook charr are compared with those of the aurora charr.

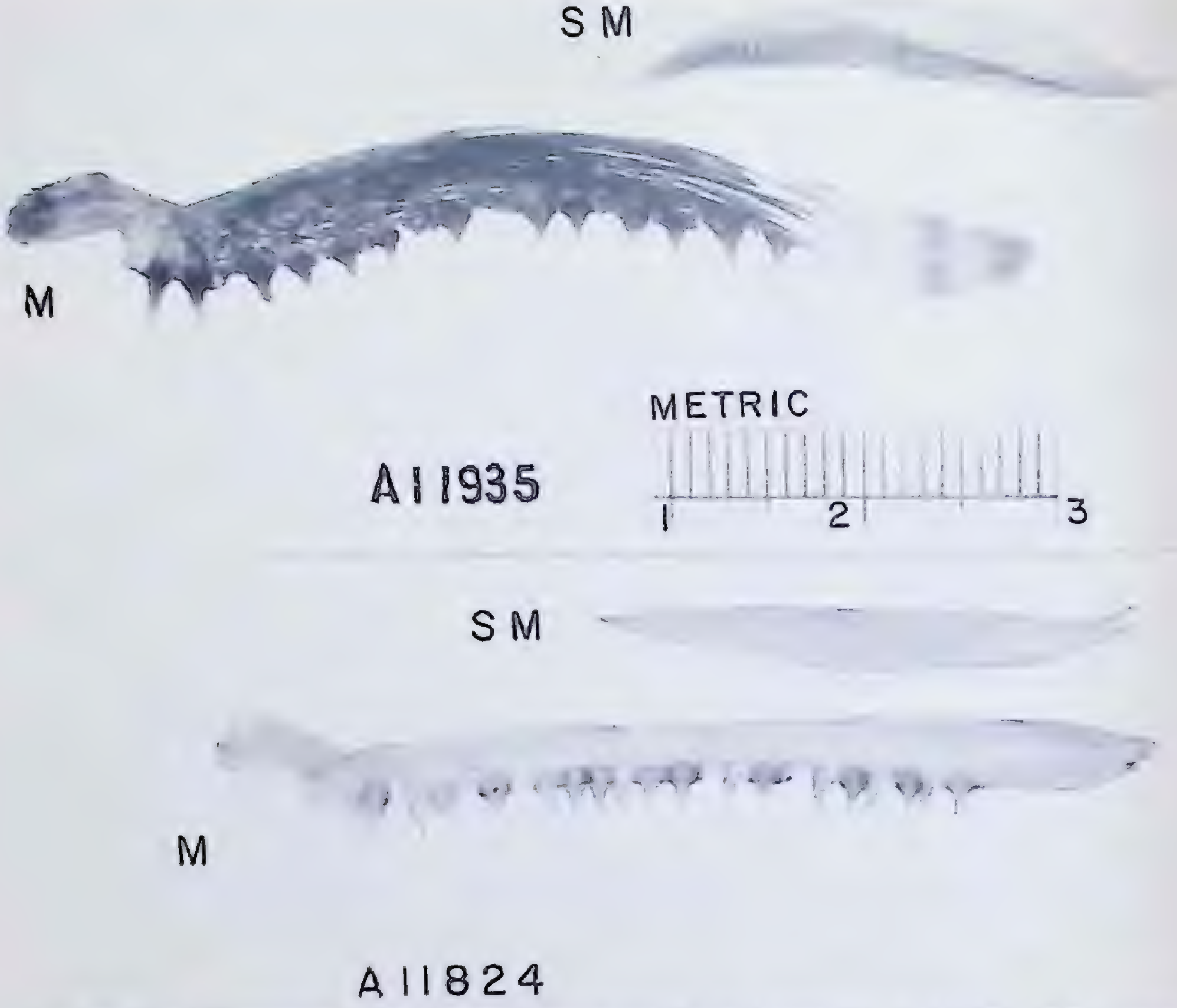

FIGURE 2—Differences in the shape of supramaxilla and maxilla: A 11935—*S.f. timagamiensis* from Whirligig Lake, fork length 418 mm; A 11824—*S.f. fontinalis* from Lavieille Lake, fork length 392 mm.

OSTEOLOGY

A detailed osteological study of the brook and aurora charrs showed slight differences in the shape of the maxilla and supramaxilla. The proportions of the measurements for the maxilla, supramaxilla, and dentary were also different, but they overlapped considerably; the differences were not tested statistically. (*See* Figure 2 and Table II.)

MORPHOLOGY

Body and head parts are expressed as percentages of the fork length and head length, respectively. Only eight important proportions were considered. The range and mean ±2 standard errors as well as the ±1 standard deviation are presented in Figure 3, after Hubbs and Hubbs (1953).

Predorsal Fin Length (*aD*). This distance was slightly longer in the aurora charr than in the brook charr (Figure 3). It was also slightly longer in males than in females of both fishes. This observation suggests that the dorsal fin is more posteriorly located in the aurora charr than in the brook charr.

Distance from the Anterior Tip of the Lower Jaw to the Origin of the Ventral Fin (*ma–V*). The mean values were higher for the aurora charr than for the brook charr.

TABLE II

PROPORTIONAL MEASUREMENTS OF SOME CRANIAL BONES

Subspecies	Locality	No. of fish	Fork length of fish mm	Maxilla			Supra-maxilla	Dentary		
				$\frac{L_1}{L}$	$\frac{W}{L}$	No. of teeth including alveoles	$\frac{W}{L}$	$\frac{W}{L}$	No. of teeth including alveoles	No. of pores
S.f. fontinalis.............	1	9	178–392 (252)	13.5–17.5 (15.0)	6.5–12.7 (10.2)	18–24 (21.7)	9.1–13.6 (10.8)	26.8–34.9 (30.1)	12–24 (17.2)	6–8 (7.0)
S.f. timagamiensis......	7–9	15	146–418 (281)	13.7–19.0 (16.7)	7.6–15.5 (10.9)	14–25 (21.4)	9.1–24.2 (15.3)	23.6–32.7 (27.9)	14–24 (18.6)	6–7 (6.9)

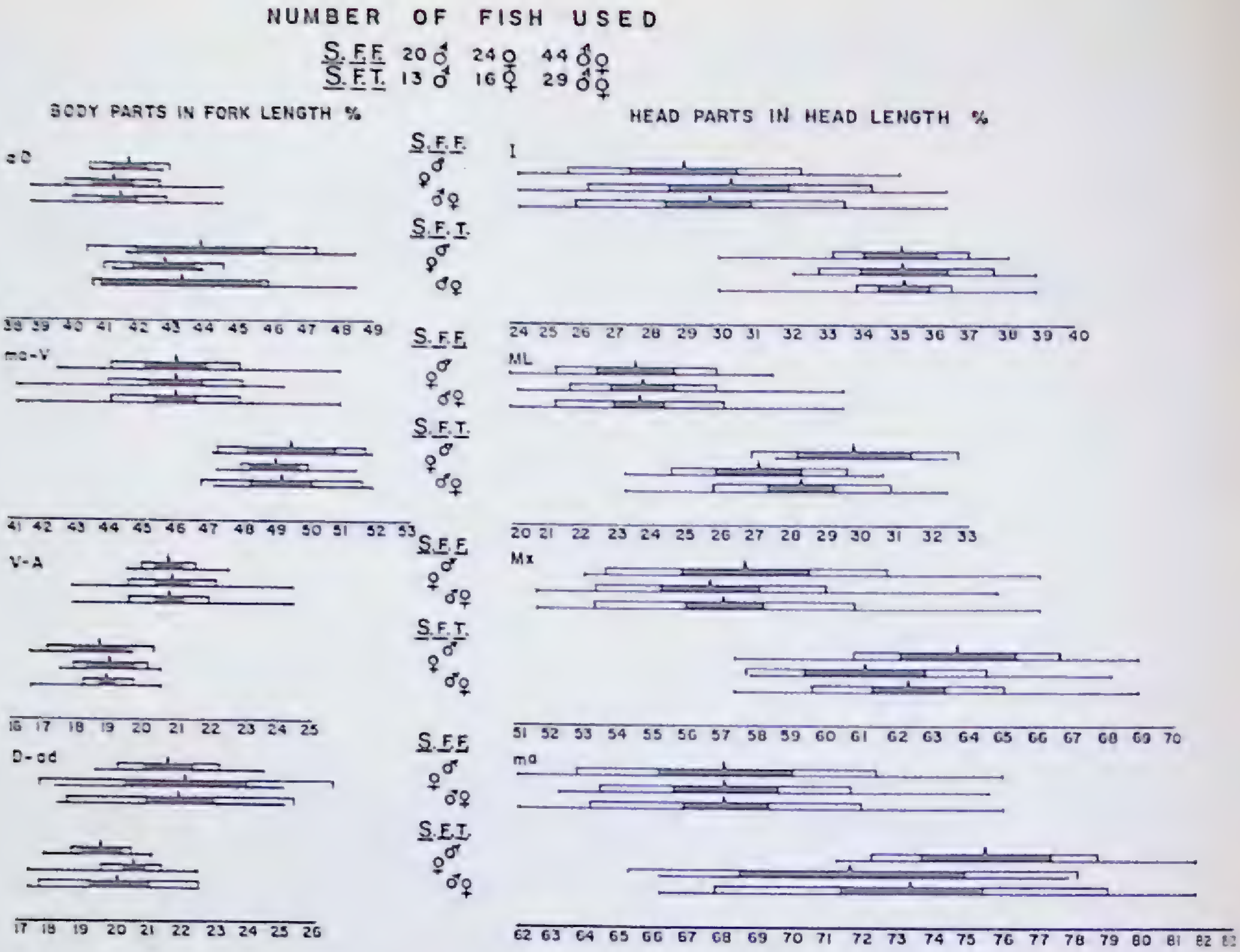

FIGURE 3—Percentage proportions of body parts and head parts in fork length and head length respectively. The range and the mean ± 2 standard errors and ± 1 standard deviation are shown. *S.f.f.—S. fontinalis fontinalis; S.f.t.—S. fontinalis timagamiensis.*

Distance from the Origin of the Ventral Fin to the Origin of the Anal Fin (*V–A*). The values for this proportion were higher in the brook charr than in the aurora charr, though there was a little overlap between the two fishes. Sale (1964) showed that this distance was significantly smaller (significance tested at 5 per cent level) in the aurora charr. This indicated that the anal fin is somewhat more anteriorly located in the aurora charr than in the brook charr.

Distance from the Insertion of the Dorsal Fin to the Origin of the Adipose Fin (*D–ad*). The mean values for this proportion were higher in the brook than in the aurora charr, and the values for the females were higher than those for the males. It is apparent that the adipose fin is more anteriorly situated in the aurora charr than in the brook charr.

Interorbital Space (*I*). This space is broader in the aurora charr than in the brook charr.

Length of the Snout (*ML*). The mean for this proportion was higher in the aurora charr than in the brook charr. The length of the snout was greater in the males than in the females of the aurora charr.

Length of the Upper Jaw (*Mx*). The upper jaw was longer in the aurora charr than in the brook charr. In the mature males, the upper jaw was notably longer than in the females. Henn and Rinkenbach (1925) pointed out that the maxilla was extremely long in the aurora charr compared to other charrs. Vladykov (1954) showed that the maxilla was longest in the brook charr compared to other charrs, but he did not examine the aurora charr.

Length of the Lower Jaw (*ma*). The lower jaw of the aurora charr was longer than that of the brook charr, and in the mature males it was slightly longer than in the females.

MERISTIC CHARACTERS

Many authors have demonstrated the variability of meristic characters under different environmental conditions (Mottley 1934; Seymour 1959). Nevertheless, prudent use of these characters is helpful in taxonomic studies. Only the more important of the twenty-five or more characters studied were analysed. Variations in some meristic counts in subsamples of the two groups of fishes are presented in Tables III and IV. The mean ±1 standard error is given in the descriptions of the single neural spines and the total numbers of ribs, gill rakers, and branchiostegals.

Number of Vertebrae. The total number of vertebrae and the number of trunk vertebrae were counted.

The mean of the trunk vertebrae in the aurora charr was higher than the mean in the brook charr (Figure 4; Table III). The coefficient of difference between the two groups of fishes was 1.32, which was higher than the standard value of 1.28 for subspecific differentiation (Mayr *et al.* 1953).

In the samples, the total number of the vertebrae in the aurora charr ranged between 59 and 61, and the mean value was 60.3 (Table III). In the aurora charr, Sale (1964) stated the range and mean of the total number of vertebrae to be 58–61, and 59, respectively. In these samples, the range and mean in the brook charr were 58–61 and 59.4, respectively. Vladykov (1954) counted a range of 58–62 vertebrae in the brook charr. Sale (1964) counted a range of 58–60 vertebrae in the brook charr population from Reed Lake.

Total Number of the Single Neural Spines, Normal and Expanded. In the aurora charr the range (27–32) and mean (28.5±0.4) for the single neural spines were higher than the range (20–29) and mean (26.3±0.5) in the brook charr. The CD value of 1.31 between the brook and aurora charrs signified subspecific difference. The specimens used for this count were the same ones used for epineurals in Table IV.

Number of Ribs. The number of ribs with strongly bifid heads and the total number of ribs were counted.

The mean number of the ribs with strongly bifid heads was higher for the aurora charr than for the brook charr. The CD value of 1.48 separated the aurora charr from the brook charr (Figure 4; Table IV).

The range (31–36) and mean (33.2±0.2) for the total number of ribs for the brook charr and the range (33–36) and mean (34.5±0.3) for the aurora charr differed slightly. But the range of the number of ribs overlapped in the two groups (CD 0.71). Forty-one brook and 28 aurora charrs were used for this count.

Total Number of Epineurals. The number of epineurals in the aurora charr was higher than in the brook charr. The CD value of 1.31 separated the aurora charr from the brook charr (Figure 4; Table IV).

TABLE III

TRUNK AND TOTAL VERTEBRAE IN THE TWO SUBSPECIES[1]

Subspecies	Locality	No. of fish	Trunk vertebrae						Total vertebrae					
			Range	$\bar{X}$	Me	s	$s_{\bar{x}}$	CD	Range	$\bar{X}$	Me	s	$s_{\bar{x}}$	CD
S.f. fontinalis	1	11	26–28	27.5	28	0.82	0.26		58–60	59.2	59	0.85	0.27	
	2	6	27–29	28.2	28	0.53	0.24		58–60	59.0	59	0.82	0.37	
	4	10	27–29	28.2	28	0.75	0.18		59–61	59.7	60	0.64	0.21	
	5	7	27–29	28.0	28	0.75	0.31		58–60	59.0	59	0.76	0.31	
	6	7	27–28	27.3	27	0.00	0.00		59–61	60.3	60	1.02	0.44	
	Total 41		26–29	27.8	28	0.93	0.15	1.32	58–61	59.4	59	0.79	0.13	0.62
S.f. timagamiensis	7	15	29–31	29.9	30	0.24	.06		59–61	60.2	60	0.66	0.18	
	8	6	29–31	30.0	30	0.57	0.25		60–61	60.2	60	0.32	0.14	
	9	5	30–30	30.0	30	0.00	0.00		60–61	60.4	60	0.49	0.25	
	10	3	31–31	31.0	31	0.00	0.00		60–61	60.7	61	0.44	0.31	
	Total 29		29–31	30.6	30	0.76	0.14		59–61	60.3	60	0.57	0.11	

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[1] $\bar{X}$, mean   s, ± standard deviation   CD, coefficient of difference
Me, median $s_{\bar{x}}$, ± standard error

TABLE IV

RIBS WITH STRONGLY BIFID HEADS AND TOTAL NUMBER OF EPINEURALS IN THE TWO SUBSPECIES[1]

Subspecies	Locality	No. of fish	Strongly bifid ribs						No. of fish	Total epineurals					
			Range	$\overline{X}$	Me	s	$s_{\bar{x}}$	CD		Range	$\overline{X}$	Me	s	$s_{\bar{x}}$	CD
S.f. fontinalis........................	1	9	21–26	23.7	24.0	1.65	0.58		11	29–35	32.3	33.0	2.24	0.71	
	2	6	24–27	25.7	26.0	0.85	0.38		6	30–33	31.8	32.0	1.17	0.52	
	4	10	22–27	24.0	24.0	1.04	0.44		–	–	–	–	–	–	
	5	7	23–26	24.3	24.0	1.07	0.35		–	–	–	–	–	–	
	6	7	25–27	25.6	25.0	0.94	0.38		7	32–35	33.7	34.0	1.11	0.45	
	Total 39		21–27	24.5	24.0	1.56	0.25	1.48	24	29–35	32.6	33.0	0.74	0.15	1.31
S.f. timagamiensis.................	7	15	27–30	28.3	28.0	1.04	0.28		10	34–38	35.7	36.0	1.49	0.49	
	8	6	28–30	28.8	29.0	0.81	0.36		–	–	–	–	–	–	
	9	4	27–30	28.0	27.5	1.22	0.71		5	35–42	37.4	37.0	2.79	1.35	
	10	3	28–30	29.0	29.0	0.82	0.58		–	–	–	–	–	–	
	Total 28		27–30	28.0	28.0	1.10	0.21		15	34–42	36.3	36.0	2.05	0.55	

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[1] *See* footnote Table III.

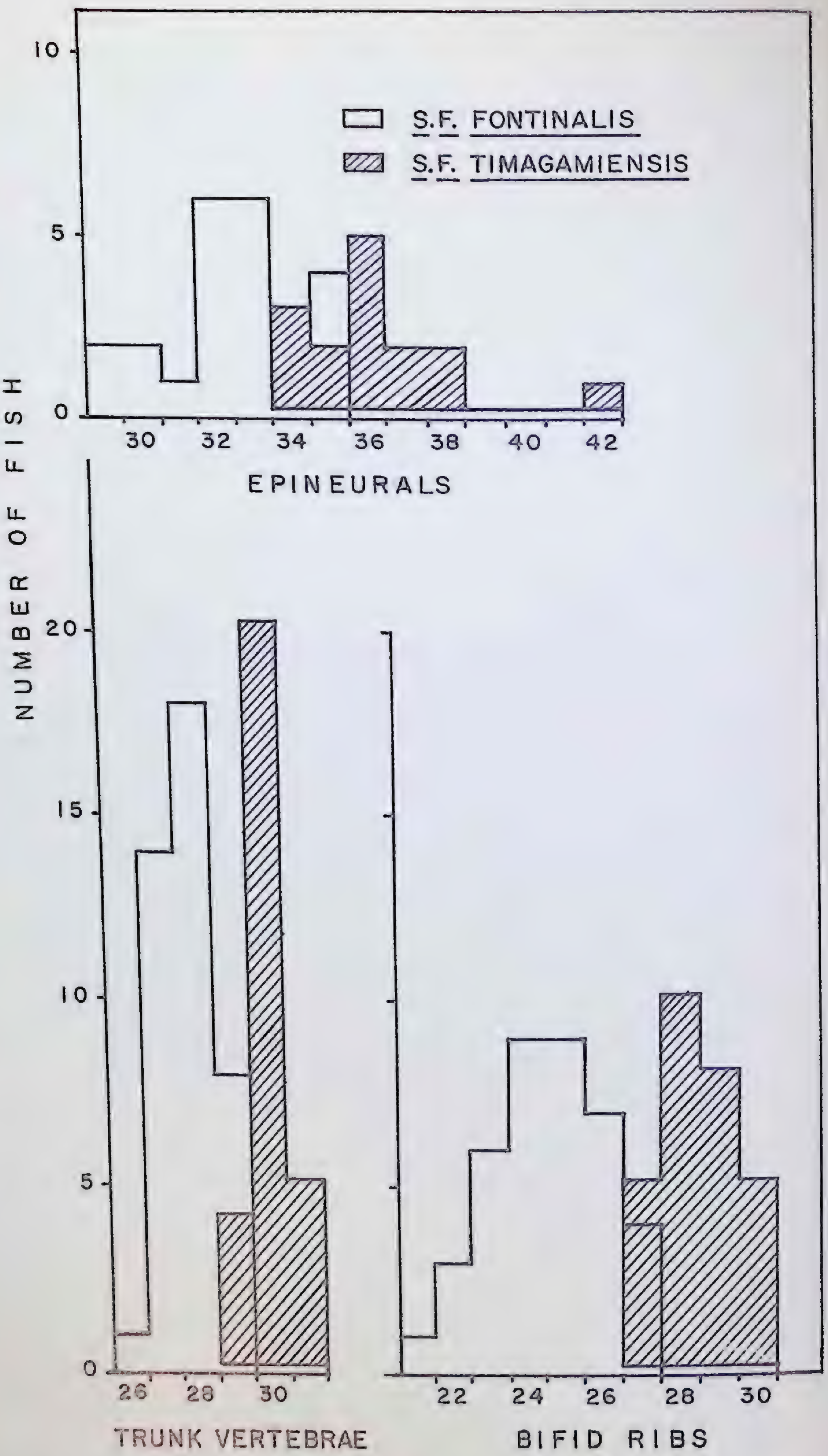

FIGURE 4—Histograms of number of epineurals, strongly bifid ribs, and trunk vertebrae.

Number of Rays in the Single and Paired Fins. The fish used for vertebral counts in Table III were also used for fin ray counts.

The brook charr range (12–15) for the dorsal fin rays overlapped the aurora charr range (13–14), and the means were 12.9 and 13.5, respectively. The values for the brook charr were higher than those reported by Wilder (1952). Vladykov (1954) reported a mean of 10.3 for his sample. Sale (1964) reported a low count (mean of 10.0) for the aurora charr.

The range (10–13) for the anal fin rays in the brook charr overlapped the aurora charr range (11–13), and the means were 11.7 and 12.1, respectively. These values were higher than those of Wilder (1952). Vladykov (1954) reported a mean of 9.5 for the brook charr. Sale (1964) reported a mean of 9.1 for the aurora charr.

No difference was observed in the range (12–15) and mean (13.2) for the pectoral fin rays between the brook charr and the aurora charr (range 13–14; mean 13.1). Vladykov (1954) reported a mean of 12.9 for the brook charr, and Sale (1964) reported a mean of 12.8 for the aurora charr.

In both the brook and aurora charrs, the range (8–9) and mean (8.3) for the pelvic rays were the same. Vladykov (1954) reported a mean of 8.1 for the brook charr, and Sale (1964) reported a mean of 8.5 for the aurora charr.

Number of Gill Rakers. This characteristic has been used extensively in salmonoid taxonomy (Svärdson 1957; McPhail 1961). Forty-one brook charr and 24 aurora charr were used for this count. No difference was observed in this characteristic between the brook charr (range 15–22; mean 18.2 ± 0.5) and the aurora charr (range 17–22; mean 18.3 ± 0.2). For the brook charr, Vladykov (1954) reported a mean of 17.7 for the left side and 18.4 for the right side of the fish. Sale (1964) reported a mean of 16.1 for the aurora charr from the left side of the fish.

Number of Branchiostegals. Forty-one brook charr and 27 aurora charr were used for this count. The range (11–14) and mean (12.0 ± 0.1) for the branchiostegals in the aurora charr were higher than the range (10–12) and mean (11.3 ± 0.1) in the brook charr. For the brook charr, Vladykov (1954) reported means of 10.8 and 10.3 from the left and right sides of the fish, respectively. Sale (1964) reported a mean of 12.0 for the aurora charr.

Colour and Biology

Colour pictures and descriptions of the brook charr were published by Wilder (1952), Vladykov (1953), Hubbs and Lagler (1958), and MacKay (1963). Sale (1964) included colour photographs of the aurora charr in his M.A. thesis. Coloured pictures of the brook charr in its various populations showed slight colour differences, which depended on whether the fish came from a stream, from a shallow or deep lake, or from salt water.

Basically, the adult brook and aurora charrs are similar in body and fin coloration. The yellow spots or vermiculations that are present in the brook charr were not observed in the aurora charr by earlier workers, but the diffused vermiculations were observed in preserved specimens (Figure 5). Also the number of red spots surrounded by blue haloes was much higher in the brook charr than in the aurora charr (Sale 1967).

The coloration of the brook and aurora charr juveniles is very similar.

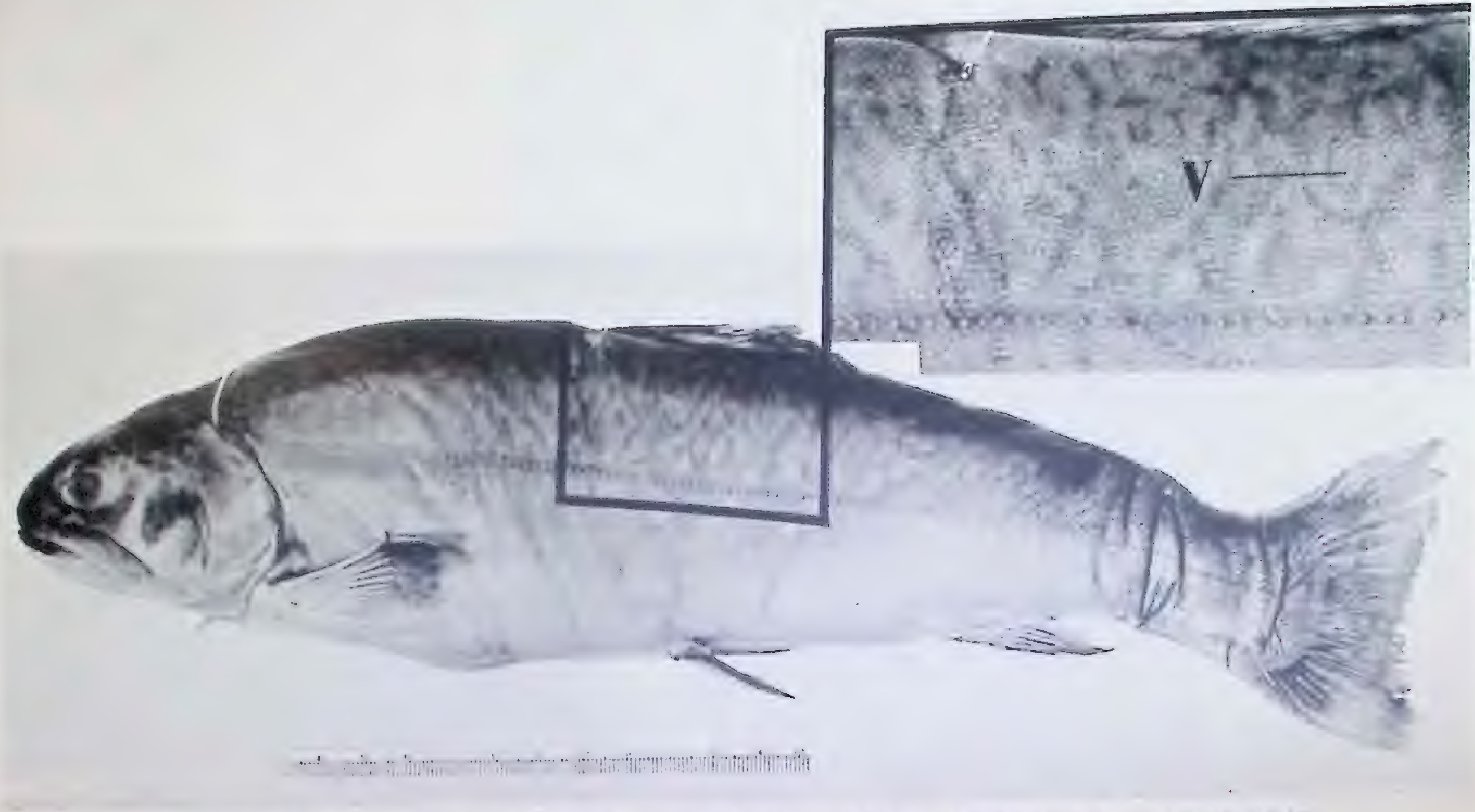

Figure 5—Dark vermiculations (v) in a formalin-preserved specimen of *S.f. timagamiensis* from Whirligig Lake: NMC 66-556, fork length 325 mm. A rectangular area on the lateral side of the fish is enlarged 2.5×.

I believe the slight quantitative differences in colour between the two fishes should not demand a specific ranking for the aurora charr, particularly when there is large variation in colour in the different populations of the brook charr.

Both fishes have similar incubation periods and rates of growth, both mature in two to three years, and both are omnivorous. The aurora charr and the lake-spawning brook charr spawn late in the fall in shallows of the lakes (Sale 1967).

The presence of the parasitic copepod, *Salmincola edwardsii*, in the aurora charr was reported on all the smaller specimens by Henn and Rinkenbach in 1925. In North America, this parasite is specific to the brook charr (Savage 1935; Davis 1956; Lagler 1956; Cameron 1958), a fact which may indicate that the aurora and brook charrs belong to the same species.

SUBSPECIES CONCEPTS

Most modern taxonomists believe in subspecific nomenclature (Bailey *et al.* 1954; Hubbs and Lagler 1958; Simpson 1951; Mayr 1963). But Wilson and Brown (1953) and Gosline (1954) are strong opponents of subspecific ranking and trinomial nomenclature and prefer to describe such populations in a sentence or two. I subscribe to the former view.

Mayr (1963) defines a subspecies as follows: "A subspecies is an aggregate of local population of a species, inhabiting a geographic subdivision of the range of the species and differing taxonomically from other populations of the species." He also points out that a subspecies may consist of many local populations, which vary from each other genetically and phenotypically, and that the range of the species may be discontinuous. Adjacent subspecies interbreed or are potentially capable of doing so if separated by extrinsic barriers. Two misconceptions about the subspecies must be corrected. First, a subspecies is not necessarily an incipient species of the typology (Simpson 1961); relatively few subspecies will ever become species. Secondly, the subspecies does not express the geographic variation of a character (cline) of a species; it is only partly descriptive of that variation.

To qualify as a subspecies, an assemblage of populations must be taxonomically different from other subspecies. The differences between the populations must be sufficiently great so that it is possible to identify the majority of specimens without the knowledge of their origin. For that purpose many taxonomists adhere to a 75 per cent (Mayr *et al.* 1953) and others to a 93 per cent rule (Bailey *et al.* 1954). A CD value of 1.28 separates 90 per cent of the animals of one population from 90 per cent of the animals of the other population.

The coefficients of difference for several meristic characters show that the aurora charr differs from the brook charr in the numbers of trunk vertebrae (CD 1.32), single neural spines (CD 1.31), and ribs with strongly bifid heads (CD 1.48), and in the total number of epineurals (CD 1.31).

Natural breeding populations of the aurora charr are geographically isolated in Whirligig Lake. The aurora charr in Wilderness Lake hybridized freely with the introduced brook charr (Sale 1967). Also hydridization was frequent where the brook and aurora charrs occurred together in Whitepine Lake. The presence of extensive hybridization between the two forms forces us to abandon the belief that *S. timagamiensis* is a distinct species.

I tend to agree with Radforth (1944), who speculated that the aurora ch originated as a result of some fish of the parental brook charr stock becomin geographically isolated in Whirligig Lake when the retreat of the glacier and su sequent draining of Lake Ojibway gave place to the present watershed. Th fish later developed certain taxonomic differences that gave rise to the aur charr.

CONCLUSION

When the cumulative evidence of morphological and meristic characters, the presence of the same parasitic copepod, of the geographic isolation, and the presence of hybridization between the aurora and brook charrs in nature considered, it must be concluded that the aurora charr is a subspecies of t brook charr and not a distinct species. It is therefore designated as *Salveli fontinalis timagamiensis* Henn and Rinkenbach.

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